Accuracy and Reproducibility of RV Volumes and Systolic Function Measurements by CMR Using Short Axis vs Long Axis Four Chamber Views

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Introduction

Cardiac magnetic resonance (CMR) is the reference standard for right ventricular (RV) volume and function assessment. A stack of short-axis slices (SAX) is routinely used to measure RV volumes but basal slice selection is challenging due to tricuspid annular plane excursion. Long-axis views offer a clearer view of the tricuspid and pulmonary valve planes, eliminating the need for cross-referencing; yet, there is a significant partial-volume variability due to large areas of tangential subendocardial borders not perpendicular to the plane.

Objective

To evaluate the agreement between SAX and parallel long-axis slices in a 4-chamber orientation (4ch) for measurements of RV end-diastolic (EDV) and end-systolic (ESV) volumes and RV ejection fraction (RVEF).

Methods

Study population

50 patients with adequate image quality in SAX and 4ch orientations were identified among patients referred for a clinically indicated CMR exam on 1.5T (Philips Intera) or 3T (Siemens Skyra) scanners between May 31 and July 12 2013.

Baseline characteristics

Age (years)	56 (18)
Female gender (%)	36
RVEDV in SAX (mL)	162 (65, 80-343)
RVESV in SAX (mL)	80 (48, 26-252)
RVSV in SAX (mL)	81 (29, 36, 148)
RVEF in SAX (%)	52 (11, 18-67)
LVEF (%)	51 (15, 13-75)
Indications for CMR (N)	**50**
Dilated CM	8
Hypertrophic CM / LVH	7
Myocardial infarction	7
Aortic valve disease	7
Arrhythmia / miscellaneous	7
Congenital heart disease	6
Other CM	4
Restrictive CM	2
ARVC	2

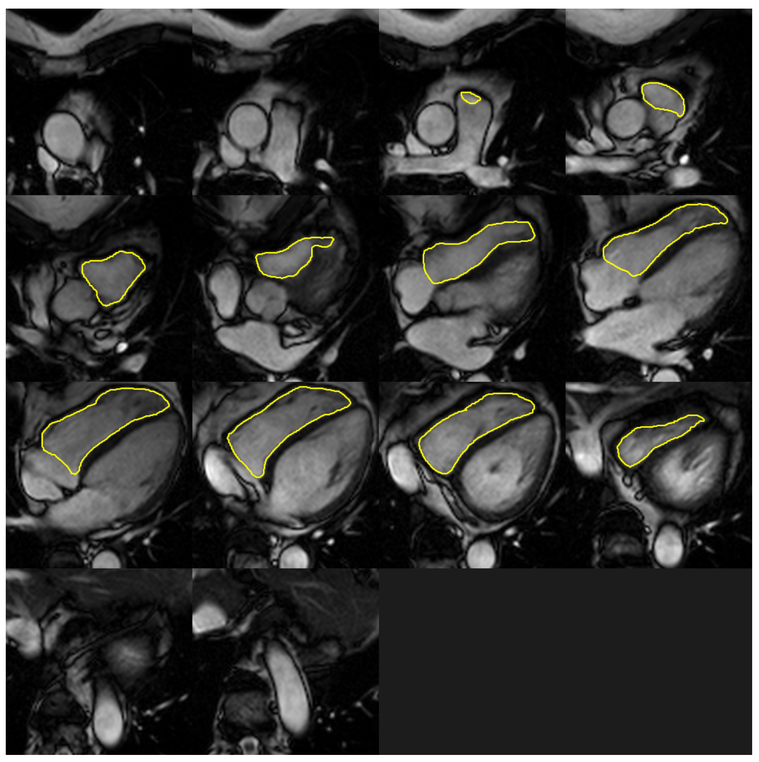
Mean (SD, range); CM: cardiomyopathy

RV volumes measurements

EDV and ESV were measured with the method of discs, tracing the RV endocardium on stacks of cine CMR slices (8 mm, no gap) in SAX and 4ch with median (IQR) number of slices as below:

Cine slices	4ch	SAX	p
Acquired	14 (13-15)	14 (14-15)	0.01
Traced	11 (10-12)	12 (10-13)	0.057

RV endocardial tracing in 4-chamber view



Results

Bland-Altman analysis for RV volumes and RVEF comparing SAX and 4ch measurements

	Mean difference	Limits of agreement
RVESV	1.8 mL	-37.7 – 41.3 mL
RVESV	0.6 mL	-19.8 – 20.9 mL
RVSV	2.1 mL	-28.6 – 32.9 mL
RVEF	0.8%	-8.7 – 10.2 %
Indexed RVEDV	1.0 mL/m^2	-17.8 – 19.9 mL/m^2
Indexed RVESV	0.2 mL/m^2	-10.3 – 10.8 mL/m^2

Fixed and proportional bias between SAX and 4ch measurements of RV volumes using linear regression

	Fixed bias (Intercept ≠ 0)		Proportional bias (Slope ≠ 1)		Bias	
	Intercept	95% CI	Slope	95% CI	Fixed	Proportional
RVEDV (mL)	9.4	-7.3 – 27.9	0.9	0.1 – 1.1	**No**	**No**
RVESV (mL)	-3.6	-12.2 – 1.7	1.1	1.0 – 1.2	**No**	**No**
RVSV (mL)	5.2	-7.2 – 15.3	1.0	0.8 – 1.1	**No**	**No**
RVEF (%)	-8.4	-17.7 – 0.5	1.2	1.0 – 1.3	**No**	**No**

Agreement between SAX and 4ch for RV dilatation and dysfunction

N = 50	kappa	95% CI
RV dilatation	0.79	0.55 – 1.02
RV dysfunction	0.86	0.68 – 1.05

RV dilatation defined as EDV ≥ 110 mL/m2 for males and ≥ 100 mL/m2 in females and RV dysfunction defined as RVEF<45%.

Intraobserver concordance correlation coefficients for RV volumes and RVEF between 2 cardiologists

N = 10	4-chamber	SAX
RVEDV	0.97	**0.99**
RVESV	**0.97**	0.89
RVSV	**0.91**	0.86
RVEF	0.73	**0.86**

Interobserver concordance correlation coefficients for RV volumes and RVEF between 2 cardiologists

N = 14	4-chamber	SAX
RVEDV	0.98	**0.99**
RVESV	0.97	**0.99**
RVSV	0.92	**0.93**
RVEF	**0.89**	0.74

Conclusions

Parallel long axis views in a 4ch orientations and SAX views provide similar results for RV volumes and RVEF, but the limits of agreement are wide. Agreement is good to very good for determination of RV dilatation and dysfunction. Intraobserver and interobserver agreement are not substantially different between the two techniques.

Disclosures: none